

THE

PSYCHOLOGICAL BULLETIN

THE PRESENT STATUS OF MEMORY INVESTIGATION.

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Two decades of experimental investigation have quite changed our conceptions of memory. A host of new questions raised by the facts discovered are before us in place of a small group of old problems. The nature of retention, the laws and forms of association, the rate of forgetting, the nature of the memory image were the topics in the foreground of discussion when Ebbinghaus initiated a scientific method for the study of memory. Some of these are still living questions, but the main interest has shifted into other directions. With the new method rapid progress has been made. The attempt to establish the memory curve for different time intervals and to determine the various conditions upon which the amount remembered depended was the main issue of the first decade of memory investigation. This, however, aimed only at determining the quantitative facts, the degree and manner in which the amount remembered varied with the nature of the material, age, sex, general intelligence, sense department, and other factors. Seeking an explanation for the facts followed logically as the next step. For the past several years the majority of quantitative memory studies have aimed to find this explanation in the analysis of the manner of learning and of recalling. The analysis of the memory consciousness has come to the foreground of memory investigation. In the meantime a number of other lines of memory studies have been opened. In the present brief survey of the field I shall attempt to consider the main groups of problems under the following headings: (A) The nature of memory curves and other quantitative determinations. (B) Memory analysis and the explanation of quantitative results. (C) Economy of learning and memory training. (D) Memory illusion.

A. The Nature of Memory Curves and other Quantitative Determinations. — The problem in establishing a memory curve is that of determining the rate of change, and its variations, in the memory of a given material as affected by the lapse of time from the moment of its perception until no trace of memory of that material remains. This has been measured in part in different ways. First, by the unaided recall method determining the amount recalled. Second, by the recognition method. Third, by finding the time saved in re-learning the material used. Fourth, by the recall method in which the units of the material are learned in pairs and one of each pair is presented a second time. Fifth, by measuring the time required for recall. That this curve would probably vary according to a number of different conditions was at once obvious. Quantitative memory studies have therefore been made (1) with material of different degrees of simplicity and continuity; (2) the material has been presented to different sense departments; the influence (3) of age, and (4) of general intelligence has been studied. The majority of the investigations made are concerned with two or more of these problems, and during the past several years quantitative studies have often aimed at the same time at the analysis of the memory consciousness.

1. The Simplicity and the Continuity of the Material. We may draw an arbitrary line between (*a*) simple and (*b*) complex material. To the former will then belong the pitch of a tone, the brightness of a grey or saturation of a color, visual distance, an unfilled time interval, and the like. Under the latter will be classed groups of colors, numerals, letters, nonsense syllables, words, forms, and objects. In both, the units have no necessary connection with each other. Both are therefore to be distinguished from what we may call (*c*) connected experience. Here belong passages of prose or poetry, a complex picture with variety and detail of content, the experience of an event. Obviously many other things might be mentioned under each of the three classes of material, but these are the things that have been actually employed in memory investigation.

The general character of the memory curve for simple material may be said to be established. The results obtained by the different investigators are in essential agreement. Relatively few of the quantitative studies with the complex material have aimed at the establishment of a memory curve. Their object has usually been the comparison of the different kinds of complex material and the study of the other factors, for which purpose only one recall, immediately after presentation, was employed. Of those in which more than one recall was

made the number has been limited to three or four, and none with the recall method have employed time intervals near the point at which all memory of the material had disappeared. Ebbinghaus' study, repeated by Radossawljewitsch using the same method,¹ gives the only results at present on the point in question. We, therefore, have as yet no memory curve for complex material which shows the whole course of decline in the ability to recall. On a memory curve for connected experience we have still less. In fact, no investigations have yet made that problem their aim. A few studies on memory illusion using this class of material, and giving the amount recalled correctly as well as the errors, have employed several time intervals.

2. The Dependency on the Sense Department. To determine the memory curve for each of the sense departments, keeping all the other objective conditions the same, would be a very difficult task, if not impossible to accomplish. This has never been attempted. Nor has any investigation been undertaken that compares the complete memory curves for any two sense departments. What we have in place of this are studies comparing visual and auditory presentation of the material for immediate recall, and determining the influence of accompanying motor processes. With some exceptions the material used has been verbal, and its vocalization is the motor process that has been considered. The general outcome of these studies may be stated in a word. Vocalization of the material while learning increases the ability to recall it considerably. Visual presentation of meaningless verbal material is always better than auditory presentation. But auditory presentation of meaningful verbal material is better than the visual with the younger school children. Thus we see that the dependency of the memory curve on the sense department has already been shown to be further conditioned by at least two factors — material and age.

3. The Dependency on Age. That at a certain period of childhood memory is better, at least for some things, than it is later was a general opinion before the question was studied experimentally. We know now that for immediate recall the ability to recall what has been once seen or heard increases gradually until maturity, some fluctuations appearing at puberty. Whether this is a change in actual memory ability is left for memory analysis to decide, and the indications so far are that it is due to the development of other functions. These results on the change in the memory span with age, however,

¹ 'Das Behalten und Vergessen bei Kindern und Erwachsenen nach experimentellen Untersuchungen,' *Päd. Monographien*, I. Bd., 1907.

do not give us memory curves for delayed recalls after different time intervals. Again, no studies on this have been undertaken with the recall method. Radossawljewitsch has repeated Ebbinghaus' experiment with children of different ages as well with adults. He found that the time saved in re-learning decreased with age for all but the five- and the twenty-minute intervals. But the number of repetitions required for learning the first time was greater for the younger children.

4. Dependency on General Intelligence. The relation of memory to general intelligence received attention early in memory investigations and has been an object of occasional interest since. On the whole, the memory span has been found to increase with general intelligence as indicated by school grades, but with marked exceptions occurring. Whether memory permanency bears the same relation to general intelligence as does the memory ability in immediate recall we do not know. Since the memory span is largely determined by a brief concentrated effort while memory permanency is more dependent on repetition in learning, it is likely that this relation is quite different for the delayed recalls.

Thus we see that the main line of quantitative studies has been concerned with the various objective conditions that influence immediate recall. Memory curves showing the whole course of decline of memory for different time intervals have been established only for the simple material, with the recognition method, and for nonsense syllables, with the Ebbinghaus method. Scattered results are bringing to light the importance of determining the whole memory curves for all the conditions that influence immediate recall. Considering the variety of factors that enter into the manner of learning and of recall and how these are influenced by objective and subjective conditions, it is not likely that these conditions affect the delayed recalls in the same way and degree as they do immediate recall. Since some things we wish to remember only for the moment of a given occasion while others we want never to forget, it becomes important to know the whole memory curve with all the conditions that affect each part.

B. Memory Analysis and Explanation of Quantitative Results.—The differences in the amount remembered for the different conditions have been used as a means of analyzing the processes in consciousness. We may therefore speak first of objective methods of analysis.

1. Objective Methods of Analysis. The procedure consists of varying the objective conditions of learning a material with the aim of hindering, eliminating, or of helping a certain mental process, and

then inferring as to the presence and importance of that process from the amount that is remembered in the different cases. Thus from results obtained in this way we have made inferences (*a*) as to the rôle of associations in memory in comparing simple and complex material, finding that according to the nature of the material all may be forgotten in the course of a minute or a certain portion of it may be remembered permanently. (*b*) In comparing visual and auditory presentation of the material without distraction, we have inferred from the amount remembered as to the relative prominence of visual and auditory processes. (*c*) In regulating the accompanying motor processes, especially vocalization, we have determined the part this plays. (*d*) The last has been termed the distraction method, which has been employed also in further comparing visual and auditory presentation. Going on the principle that visual stimuli distract visual processes more than they do auditory processes, and auditory stimuli distract auditory processes more than they do visual, such distracting stimuli have been introduced during the visual and the auditory presentation of the material to be memorized. Three other objective methods have been used, but less frequently. (*e*) In presenting the material the subjects have been asked to direct their attention in the one case to its visual aspect, in the other to its auditory aspect. (*f*) In the use of verbal material different classes of words have been chosen designed to suggest imagery from the different sense departments. (*g*) The material has been arranged in different spatial orders in presentation, designed to aid the visualist in different degrees, and assumed to affect less the learning or memory of those of a non-visual type.

The assumptions underlying these methods are not often clearly stated, and to this extent, of course, it is not always evident what is to be inferred from the quantitative results as to the factors in the memory consciousness. The correctness of the assumptions apparently made has for the most part not been tested by direct, introspective observation. There are some indications that we have made probably a number of errors with the objective methods of analysis. We may call attention to the following: (*a*) The difference in the ability to remember simple and complex material and connected experience is probably not due entirely or even mostly to a difference in associative connections that appear in consciousness, but is influenced probably by other, quite different factors. (*b*) So far as associations enter, we should also distinguish between their presence and function in learning and their presence and function in recall. They are probably more numerous in the former than in the latter and their manner

of functioning different. (c) Presenting a material to different sense departments and proving a better memory for one than for the other is not reliable evidence that the subjects in question work or think more in the corresponding class of imagery even for the particular kind of material that is used. It may be a result of associated processes that enter in different degrees for the two sense departments. We may call attention, for example, to vocalization and concrete imagery in the case of presenting verbal material visually and auditorily. (d) Classes of words chosen to suggest certain classes of imagery may not do so when used as material in a memory experiment, as has been shown.¹

If these suggestions and others that might be added were all valid objections, it is not to be concluded that all objective methods of analysis should be cast aside as misleading and useless. This would limit us to the analysis of the memory of normal, adult, and even laboratory trained subjects. The proper procedure, as it seems to the writer, would be to employ direct observation first, and work out the analysis of memory as influenced by the objective conditions of the methods. This would at least lead to the discovery of the variety of factors with which we have to deal, though not to an extensive knowledge of the different ways of their combined functioning with different individuals. It would thus not do away with the need of objective methods of analysis, but would give us a basis for developing more reliable ones. The general course of memory investigation has reversed this procedure.

2. Analysis by Direct Observation. With several exceptions only, the introspective method has never been the chief one used in any individual memory study. But occasional introspective observation, where the dominant interest is still in the objective results, has been considerably on the increase. In the memory studies proper, however, it has been directed for the most part to the learning process, and not to the analysis of the manner of recall. Thus a good deal has been determined in this way about the presence and nature of vocalization, of associated imagery in learning a given material, and about the manner of influence of a variety of conditions of too miscellaneous a nature to be reviewed here. The manner of recall has not received much attention, if we exclude the results of mental imagery studies. Indeed, the results of these are of no great avail in any given memory study. The learning of any memory material sets up a number of

¹ Pohlmann, *Experimentelle Beiträge zur Lehre vom Gedächtnis*, Berlin, 1906.

processes in an extraordinary complexity of functional relationship that varies with every changing factor. To know simply the type of mental imagery as determined by the usual methods gives us but meager detail on what the total recall process may be like. We may say confidently that the latter is not a repetition of the processes present in learning in any case. The problem is to unravel the complex in both learning and recall and establish the differences between the two for each given case. The determination of the type of imagery thus becomes one step in the analysis of the recall process in every memory investigation that aims at this analysis. Some attempt at this determination has been a part of a large number of the more recent studies that still aim primarily at other matters.

With objective methods of analysis mostly yet in the state of development, and no extensive use made of direct observation, it follows that we have not progressed far in the analysis of the memory consciousness. A good mass of data has accumulated on the conditions that influence the rate of learning and the permanency of memory. But we have for the most part no established explanations of these quantitative results, which await the analysis of the mechanism of consciousness that produces them. This is the field in which lie the immediate and most urgent problems.

C. Economic Methods of Learning and Memory Training.—In the older psychology the laws of association alone accounted for recall. To the *a priori* deductions of these laws was added James' dictum that native retentiveness in memory is unchangeable. This might seem, and undoubtedly has seemed to many, to hold out but meager hopes that anything should be discovered that would improve learning and memory. We have quite outgrown this view. Problems concerning economic methods of learning are increasing rapidly, and they are leaving the laws of association and the question as to the permanency of native retentiveness out of consideration. The general aim of the studies here is clear. The objective conditions under which a material may be learned may be varied in numerous ways. The mental processes naturally induced under any of these conditions have been found to be very complex. Without changing the objective conditions, the learner may consciously change and direct his manner of learning in a large degree. Will one naturally find and follow the best methods of learning? This is not to be assumed, and has been found to be by no means the case. Thus we have given the general problem of finding the objective conditions of learning, and the manner of directing the learning consciously that will save the most time in

learning and produce the greatest permanency of memory. Obviously in this field also we may employ objective methods only, and determine the objective conditions that will give the best quantitative results, or we may in addition use direct observation in the analysis and determination of the conscious processes that produce them. The former, being the purely empirical procedure, does not give us the rational guide in finding the most favorable conditions for learning and memory that the latter offers in the explanation of the quantitative results that it can give. On the whole, more attention has been given to analysis by direct observation in the studies on economic methods of learning than in those already considered.

In considering the results no definite line can be drawn between these studies and those just discussed. Practically all that contribute anything to a knowledge of the conditions on which the amount that can be remembered depends, and to the analysis of the memory consciousness, contribute also to means of determining economic methods of learning. We can call attention only to the general results of a few problems on which investigations have been made with this immediate practical aim in view. (1) It is very much better to break up a given total learning time into several learning periods than to spend it all in one sitting, individual differences and other conditions entering to determine how much is gained by this division of time. The determination of the latter is the main issue. (2) In learning a given amount of material it is better to learn it as a whole than to learn it part by part, special conditions again to be considered. (3) Practice in learning a given kind of material improves the ability to memorize other kinds of material. Several different possible explanations have been offered as to the manner in which this general improvement is brought about. (4) The best conditions and manner of learning for immediate recall are different from those that give the most permanent memory. (5) The natural manner of learning, as well as the type of imagery in recall, varies considerably with different individuals. Methods must therefore be adapted to the individual, but few generalizations so far made holding entirely for all persons.

These investigations have employed verbal material almost entirely. This is rather an indication that we are only at the very beginning of the task set. Undoubtedly we may continue profitably for some time in the manner begun. But it seems that more practical results would be obtained if the investigations were made of the learning and memory processes just as they are found in the tasks of the schools and in life. We have learned at every point how materially a slight change in the

objective or subjective conditions of a memory experiment may affect our results. The total memory process set up in memorizing a group of nonsense syllables or other verbal material is surely very different from what is given in the memory tasks of the schools. It is therefore likely that many of the results of the present class of investigations will fail of valid application because of the many unforeseen factors that we do not discover.

D. Memory Illusion.—Only during the past few years has memory illusion received serious attention from experimental investigators. Stern and his co-workers, moved by the great need and practical value of a more accurate knowledge of the frequency of memory illusion in normal memory, have undertaken a number of studies aiming at this quantitative determination. Like the amount that can be recalled correctly, the degree of memory illusion has its host of objective and subjective conditions. A few of these have also already received consideration. The material used and the procedure has been such as to make the memory task in the experiment as nearly like that of everyday life as possible. Thus complex pictures, the witnessing of a scene, of an event taking place, have been employed. This should make the results more immediately practical in their application, but it encounters considerable difficulty in establishing a unit for the material, on the basis of which quantitative determinations must be made.

What was said above concerning quantitative studies, objective methods, and direct observation as a method of analyzing memory consciousness, may be said in regard to the study of memory illusion. The determination of the degree of memory illusion is one line of investigation; the study of its character, variety and causes, the analysis of the memory illusion consciousness is yet to be begun. The latter approaches an old problem in a new way, the study of recognitive consciousness.

THE PROBLEMS OF COLOR-BLINDNESS.

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The past few years have witnessed an unprecedented activity in the investigation of the problems of vision. A necessary consequence of the extension of our knowledge has been a definitizing of our concepts, and a recognition of more and more minute distinctions. Hand in hand with this development has come the introduction of a complex technical vocabulary — a vocabulary which has grown to such proportions as to confuse and bewilder the reader. Meanwhile the scientific literature of the topic has become so voluminous that the psychologist can scarcely master it without neglecting other provinces of his domain. While these factors have contributed to hamper the progress of the general reader's knowledge regarding many of the phenomena of vision, the situation seems to be particularly unfortunate in the matter of color-blindness.

Only one hundred and fourteen years have elapsed since Dalton first called attention to the interesting group of phenomena which are now known to be symptoms of color-blindness.¹ And while it is remarkable that such a conspicuous abnormality had so long escaped notice, it is equally remarkable that, when once pointed out and described, it excited so little interest. During the next fifty years it was scarcely mentioned in the literature; and not until toward the close of the past century did scientists come to recognize the important part which it was to play in the explanation of the facts of normal color vision. Within recent years, however, they have come to regard color-blindness as an exceedingly significant biological variation which enables them to observe, if not the evolution, at least the disintegration of the color sense. Color-blindness is not a mere idiosyncrasy — the peculiar personal possession of a particular individual. It is a typical deviation from normality — an imperfection whose essential characteristics are uniformly present in a great variety of individual cases. It is, in all

¹ An earlier reference to color-blindness dates from 1787. But in this earlier case the patient had died before an opportunity was afforded for a thorough examination, and the published account is meager and inadequate. Dalton's 'Extraordinary Facts relating to the Vision of Colors' appeared in 1794 (*Trans. of the Lit. and Philos. Society of Manchester*).

probability, the product of an arrest at a half-way stage in the development of sensory equipment. And it seems probable that a knowledge of the typical forms and of the essential character of this arrested development may throw light upon the nature of the retinal process by means of which normal color vision is accomplished. And it is for that reason that scientists have labored so assiduously in an attempt to obtain a complete description of the abnormality.

Color-blindness is still far from being a closed issue in the psychology of sensation. But while certain controverted points are still in dispute, it is possible, in the present status of our knowledge of the subject, to present numerous facts upon which all investigators are in agreement.

The individual who possesses a normal color system is capable of discriminating between a great variety of color-tones; he sees the spectrum as a continuous band — save for the Fraunhofer lines — in which each tone represents a gradual transition between its neighbor on the right and its neighbor on the left. When the conditions of presentation are no longer optimal, he may fail to discriminate between spectrally adjacent tones; but, unless the conditions be exceedingly unfavorable, he never confuses colors selected from widely separated regions of the spectrum. Now, we may regard any marked deviation from this normal capacity as a form of color-blindness. It must be borne in mind, however, that color-blindness is a defect of *color-sensing*, not of *color-naming*. The circumstance that one individual describes a certain spectral region as green or greenish, while another calls it blue or bluish, indicates nothing more than that, in the vocabularies of these two individuals, the same significance does not attach to these two color-names.

From the point of view of its origin, we may distinguish between congenital and acquired color-blindness. The congenital form is by far the more common; and it is to this form that investigators have most frequently directed their attention. Congenital color-blindness is believed to be common to about three per cent. of the human race; but in the absence of reliable comprehensive statistics one cannot do more than make a rough estimate as to its frequency. As to its distribution, it is more common in men than in women — a fact which may probably be referred to the circumstance that men for generations have had relatively little interest and little practice in the discrimination of colors. The defect is of frequent occurrence among the lower animals. Color-blindness is believed to be transmitted by heredity (Bateson, Nagel); and its prevalence among certain groups of individuals,

such as the Society of Friends, would seem to support this view. Acquired color-blindness may result from certain traumatic conditions, from disease and from the action of chemical agents. A wound in the region of the eye may produce an impairment of color vision, with little or no decrease of visual acuity for uncolored light. Certain neurotic conditions and diseases of the retina and optic nerve proper may be attended by similar changes. Doses of *santonin* and of other drugs produce typical disturbances of color vision. And it may be mentioned in this connection that a continuous chromatic stimulation, as when one sits in a colored illumination, reduces the sensitivity to that color, and hence produces an abnormal condition of color vision.

The tests which are employed for the detection of color-blindness have reached a high state of development. The earliest form of test still bears the name of *Holmgren*, although that investigator cannot claim priority for its discovery. This test, in all its various forms, consists in having the suspect select, from a variety of colored objects, those which match a given sample. While this procedure may be of service for practical purposes, provided it be superintended by an efficient examiner, its diagnostic and investigative value is limited. The *Stilling* plates consist of groups of vari-colored patches so arranged as to form more or less readily legible numerals. This test also is of slight value, save as a preliminary for a more thorough-going examination. These two, however, are the forms in common use; and *Stilling's* publication reached its eleventh edition during the past year. A much more adequate test is that recently devised by *Nagel* — himself a color-blind. It is unfortunate, however, that his scheme has recourse to color-naming — a capacity which may be subject to well-marked individual variation among persons who possess the same color sensitivity. For the purposes of the investigator, the test which employs '*Rayleigh's equations*' possesses unequalled advantages. On account of the numerous variations in cases of defective color-vision it is impossible, by any system of unchanging stimuli, to provide colors which shall appear exactly alike to any considerable number of color-blinds. It is therefore essential to devise some means of gradual variation of stimulus. This condition has been met in the scheme which resorts to a determination of the laws of color-mixing for the abnormal retina — a scheme which also provides for the expression of its results in most illuminating form. This method is essentially an extension of a plan which was introduced by *Lord Rayleigh* in 1881; it is usually referred to as the method of *Rayleigh's equations* (or *confusion equations*): It may be described as a systematic attempt to determine

what proportions of given color-tones must be combined to produce a mixture which shall be indistinguishable, in color and in brightness, from another color stimulus. For example, the examination may consist in matching a spectral yellow by an appropriate combination of spectral red and spectral green.

Every attempt to present a detailed characterization of color-blindness must encounter an obstacle in the matter of terminology. It may be stated at once, however, that two chief types of color-blindness are found. Total color-blindness consists in an inability to distinguish any color from gray. Those individuals who are able to distinguish certain colors only are said to be partially color-blind. The most frequent errors made by partial color-blinds consist in confusions between red and green, although a few cases have been reported in which yellow was confused with blue. Inasmuch as all the tones in the color system of the partially color-blind may be reproduced from mixtures of two colors (yellow and blue in the former case, red and green in the latter) such a system may be said to be dichromatic. Trichromatism would refer to a normal color system, since all possible tones may be reproduced from the mixture of three colors, appropriately chosen and appropriately combined. In the scientific literature, particularly that of Germany, color systems are usually described in terms of dichromatism and trichromatism. It seems unfortunate that a more significant terminology has not found favor; for one finds it quite as easy to speak of red-green blindness, blue-yellow blindness and normal color vision.

The red-green blind sees no difference, save in brightness alone, between a certain red, a certain green and gray. The green which confuses him has a bluish hue. It lies between the δ -line and the F -line, having a wave-length which varies, for different observers,¹ between $500\ \mu\mu$ and $490\ \mu\mu$. His other missing color is a (non-spectral) purplish red, the complement of the bluish-green. For the blue-yellow blind the neutral bands appear in the vicinity of the D -line, and at the region of the complementary blue.

The examination of red-green blinds has revealed the existence of a well-marked individual difference. And indeed the variation seems sufficiently great to justify the division of this group into two subtypes. The most striking difference appears in matches between red and gray—certain members of the group selecting a light gray while the others as uniformly select a dark gray. Von Kries has suggested

¹ It is probable that this variation in the 'neutral band' may be referred to variations in the pigmentation of the lens and of the macula.

that the latter form of abnormality be called *protanopia* and the former *deutanopia*. Here again let us pause to enter an objection to the choice of non-significant terms. The Rayleigh equations emphasize the essential difference between the two sub-types. When red and blue are mixed to match blue-green the protanope requires a relative excess of red in his purple mixture; and in similar determinations with red and yellow the protanope may demand five times as much red as the deutanope.

Besides the types of abnormality which have been described, certain less conspicuous deviations from the normal are occasionally found. The least serious of these has been called anomalous trichromatism (König). Although not fully understood as yet, anomalous trichromatism seems, when brought into relation with normal sensitivity, to present points of qualitative similarity but of quantitative dissimilarity. Attempts have been made to trace its origin, not to a retinal source, but to an individual variation in lenticular and macular pigmentation. This interesting and baffling variant was first reported by Rayleigh in 1881. In an investigation where several individuals were asked to match a mixture of spectral red and spectral green with spectral yellow, Rayleigh found that the results of most observers group themselves around a common average. Certain individuals, however, make their mixtures much redder, and other individuals much greener than the average. Here again then we must distinguish between a protanopic and a deutanopic sub-type. Investigations since Rayleigh's pioneer publication have shown that the former sub-type is much more numerous than the latter.

Another variation from normal color vision has been designated by the exceedingly inappropriate name of 'color weakness.' At an early stage in the development of our knowledge of this defect, investigators believed that it consisted in nothing more serious than a slight but uniform blunting of sensitivity to all colors. And this view still persists in the popular mind—probably as the result of the misleading character of the name by which it is commonly known. Investigation has shown, however, that the defect is much more intimately related to the typical forms of dichromatism than its name implies. The individual who suffers from 'color-weakness' is unable to pass even the least searching tests of color-blindness; and his abnormality is most strikingly revealed in the presence of reds and greens. The defect becomes most conspicuous under relatively unfavorable conditions of stimulation. Confusions are most numerous when color-stimuli subtend small visual angles; it has been established, however, that reduced

brightness and decreased saturation also make discrimination more difficult.

The practical application of the results of investigations in this field has come up for discussion in recent years. The æsthetician and the painter have interested themselves in these as in other visual problems. But the most natural direction in which to turn to find a practical application has proved to be toward the field of railway signaling. In developing means of control over railway trains, a complex system of signaling has been evolved. Here, as in the marine service, colored lights are employed for night signaling. A superficial consideration of certain defects of color vision has inspired the fear that this method of signaling is a menace to public safety. It is to be noted, however, that the objector has brought forward no evidence to show that his objection has any other than a purely fictitious foundation. Nor is it difficult to determine that the alarming conditions which he has conjured up have no counterpart in the practical affairs of railway operation. Railways, the world over, make use of colored signals; and the governments of several countries publish statistical reports of the numbers, the fatalities and the causes of railway wrecks. Now, such a country as England furnishes ideal conditions for a crucial test of the efficiency of the present system of signaling, because the English railways have to cope with an unusual combination of adverse conditions of operation, — congestion of traffic, high speed of trains, and the prevalence of fogs. Yet the English railways are noted for the infrequency of their accidents. Their fatalities have averaged so low as one per one hundred and sixty-nine millions of passengers carried; and a full year has elapsed without a single fatality. These data refer to accidents *from all causes*; and a commission recently appointed by the Royal Society reports that no accident, railway or marine, can be traced to anomalous conditions of color vision. Practical experience then shows that colored lights constitute a safe means of signaling, and that their results are in the highest degree successful even when the conditions of operation are relatively unfavorable. Is it not clear that if railway disasters are more frequent in America the cause is to be sought elsewhere than in a defective system of signaling? The Inter-State Commerce Commission (America) reports great numbers of railway disasters which may be traced to disobedience and drowsiness of employees, to defective road-bed and rolling stock, to obstructions upon the track, to the American tendency to take hazardous risks, etc. And the reader who cares to consult the Commission's reports will find that these are the causes to which the lesser safety of railway travelling in America must be ascribed.

Although we are now in possession of a goodly accumulation of facts regarding the phenomena of abnormal color vision, there are still a number of points upon which additional light is desirable. Certain technical problems still remain unsolved: What is the relative distribution of spectral brightness in normal and abnormal color systems? What is the relation of lenticular and macular pigmentation to variation from normal color vision? What are the mutual relationships of 'color weakness,' anomalous trichromatism and normal color vision?

If, however, some beneficent magician should grant the boon of an answer to but a single question, the investigator would undoubtedly demand to know just what is the character of the sensations which are possible to the abnormal. If we had a perfect description of the color systems of the various types of abnormality, few obstacles would remain in our path. Then we should be prepared to give a definite answer to the general question: Do these various types of abnormality represent a continuous series of gradations, without interruption or lacuna, between normality and complete color-blindness? Indeed, the suspicion is gaining ground that even this most extreme form is not a color-blindness at all, in the literal sense of that term. There seems reason to believe that at least the color system of the typical red-green blind contains red and green sensations; and that he may distinguish between red and green if only the stimuli be presented under sufficiently favorable conditions. Whether the hypothesis of continuous gradation, or the hypothesis of isolated types will ultimately dominate our envisagement, remains for the investigator of the future to determine.

PSYCHOLOGICAL LITERATURE.

THE WÜRZBURG MEETING OF EXPERIMENTAL PSYCHOLOGISTS.

The report of the proceedings of the second *Kongress für Experimentelle Psychologie* makes a pretentious volume.¹ The sessions extended over four days; and they were attended by upwards of one hundred and fifty persons. The meetings were organized by Professor Oswald Külpe, and presided over by Professor G. E. Müller. A novel feature which was introduced at these sessions was the presentation of a number of *Referate* upon assigned topics. The subjects reviewed were as follows: Experimental Æsthetics, by Professor O. Külpe; Feeble-Minded Children, by W. Weygandt; Individual Psychology and Psychiatry, by R. Sommer; The Psychology of Reading, by F. Schumann; Experimental Phonetics and Psychology, by F. Krueger. The summaries of the papers presented at the meetings fill a volume of 266 pages. It will be impossible for the reviewer to do more than to indicate briefly the content of the more important contributions.

I. APPARATUS.

Dr. K. Marbe demonstrated an apparatus for brief visual stimulation. It may be employed in connection with a projection lantern, and is adapted for use in large auditoriums.

Dr. F. Krueger demonstrated a laryngographic speech recorder. This apparatus has a wide range of utility, and possesses numerous advantages over other forms.

II. GENERAL.

F. KRUEGER. *The Relation of Phonetics to Psychology (with a demonstration of the Krueger laryngograph)*. Pp. 58-122. Krueger gives a lengthy review—with 125 bibliographical references—of the history of the problems of experimental phonetics, and a detailed description of the present status of the science. Inasmuch as speech is the product of an expressive movement, it stands in intimate relation with the phenomena of mind. It is impos-

¹ F. Schumann, *Bericht über den II. Kongress für Experimentelle Psychologie*. Leipzig, J. A. Barth, 1907. Pp. xviii + 266. Nine Marks.

sible to draw a sharp line of demarcation between phonetics and psychology — a fact which is recognized by the modern investigators of phonetics. An accurate analysis of speech variations is of fundamental importance in phonetic investigations. The author demonstrated a laryngograph which gives a kymograph tracing of speech movements. It is impossible here to summarize this valuable paper of more than sixty pages.

STANISLAUS KOBYLECKI. *Psychological Experimentation without Introspection*. Pp. 244-249. A defense of the thesis that introspection cannot be ignored in experimental investigation.

III. SENSATION.

L. ASHER. *The Law of the Specific Sense Energies*. Pp. 213-214. The concept of evolution is in perfect harmony with the law of the specific sense energies. No sensation quality was evolved from another; each arose from a 'virtual energy' in complete independence from every other quality. (This paper appeared *in extenso* in *Zeit. f. Psy. u. Phys.*, Abt. II., XLI., 1906, 157 ff.)

AUGUST KIRSCHMANN. *Darkness in the Domain of Light*. Pp. 224-229. The reader is referred to the author's own statement.

E. DETLEFSEN. *Farbenwerte und Farbenmasse*. Pp. 235-236. The relative brightnesses of colors may be compared and expressed quantitatively by means of a graded series of grays. Color filters aid in the analysis of mixed colors.

O. VERAGUTH. *The Galvanic Psycho-physical Reflex*. Veraguth finds that if a constant electric current be passed through the body, the galvanometer registers certain characteristic variations. This change in the conductivity of the body he calls the 'galvanic psycho-physical reflex.' There are characteristic curves of oscillation for repose, for stimulation, for expectation and for verbal association. And each oscillation is preceded by a period of latency, of several seconds duration, which elapses between the mental change (sensation, repose, etc.) and the change in bodily conductivity. The author confesses his inability to explain these phenomena; but by a method of exclusion he rules out various tentative hypotheses. Jung and Elsenhans discussed the author's finding, — the former contributing results of his own investigations of the topic.

W. SPECHT. *The Divergence of Difference Limen and Stimulus Limen as a Result of the Use of Alcohol*. (With discussion.) Pp. 194-199. The author's more extended presentation of his results is reviewed elsewhere in this issue. (See p. 311.)

IV. AFFECTION, EMOTION.

OSWALD KÜLPE. *The Present Status of Experimental Aesthetics*. (With discussion.) Pp. 1-57. The author traces the historical development of æsthetic investigation from the pioneer work of Fechner, pointing out certain phases of the evolutionary process which have been common to experimental æsthetics and to experimental psychology. His treatment deals with the methods, and the results and theories. In the discussion of the results his attitude is so uncritical as to render his statement of doubtful value. He considers, in order, the investigations with colors, with spatial forms, with rhythms and rhymes, with the comic, with the plastic and graphic arts, and with music. The classification and description of methods is a valuable contribution to the literature. The classification is as follows:

I. The methods of impression.

a. Methods with constant impressions.

1. Method of single choice. 2. Method of manifold choice.
3. Method of seriation. 4. Method of paired comparison.

b. Methods with variable impressions.

1. Method of continuous change. 2. Method of time variation.

c. Methods of simple description.

1. Method of free description. 2. Method of restricted description (questionnaire and comparison methods).

II. The reproduction methods.

a. Reproduction of the most pleasing elements, relations and arrangements of a given material.

b. Reproduction in accordance with a pattern.

c. Real production.

III. The methods of expression.

a. Registration of pulse, breathing, volume.

b. Recording of mimetic and pantomimetic phenomena.

c. Registration of movements and movement-tendencies of the limbs.

The reader cannot but be struck by the paucity of result yielded by the experimental investigation of this topic; but, as the author points out, there has, at least, been developed a technique which gives promise of achievement in the future.

H. HUGHES. *The Theory of the Emotions*. Pp. 230-231. A discussion of the dramatist's treatment of the emotions.

C. STUMPF. *Ueber Gefühlsempfindungen*. (With discussion.) Pp. 209-213. There are good reasons for believing that the feelings

are neither attributes of sensations, nor yet a second sort of mental process which is in some way connected with sensation. There seems to be a certain justification for regarding them as concomitant sensations which are super-added to the more independent sensations in whose company they come to consciousness. This conception aroused an active discussion in which Ebbinghaus, Jerusalem and others took part.

V. PERCEPTION.

E. V. ASTER. *The Psychology of the Perception of Space.* Pp. 260-263. A most naïve 'contribution to the psychological analysis of the immediately experienced impression of depth.'

HANS RUPP. *The Localization of Tactual Stimuli with Different Positions of the Stimulated Member.* Pp. 231-232. The problem was: What effect has a change of posture of the arms, hands and fingers upon the localization of stimuli applied to digital regions? The investigation was, however, confined to the temporal relations of the localizations. It was found that, when his arms are extended in front of his body, an observer is able to localize digital stimuli more rapidly than when his arms are folded. The average increase of time corresponding to the latter posture is about eleven per cent. A striking feature of Rupp's results is the fact that the localization-time for different digital regions varies between wide limits—being greatest (1019 sigma) for the second finger and least (455 sigma) for the thumb. This variation the author does not attempt to explain; but the slower localization with folded arms he refers to the fact that the (visual?) image of the hands in the normal uncrossed position tends to come to consciousness more readily, and to inhibit the image of the crossed posture. The paper appears *in extenso* in the *Zeitschrift f. Sinnesphysiologie*, XLI.

VI. ATTENTION AND WILL.

WILHELM WIRTH. *The Distribution of Attention in the Different Sense Departments.* Pp. 236-243. A continuation of an investigation reported upon at the Giessen Congress. What effect has the distribution of the attention upon the apprehension of sensory impressions? The author's method consisted in determining the difference-limen for tactual, auditory and visual sensations—an improved form of projection perimeter being employed for the latter determinations. Then he instituted a comparison between differential limina obtained (*a*) when the attention is concentrated upon the stimulus, (*b*) when the attention is concentrated elsewhere, and (*c*) when

the attention is diffused. His results show that the capacity to detect a variation of intensity of sensation is but slightly impaired by a distribution of the attention, and that the amount of impairment is approximately constant and uniform for the different sense departments.

NARZISSE ACH. *Experimental Investigation of the Will.* Pp. 251-257. This too is a supplementation of a research presented by the author at the Giessen Congress. Ach's present paper deals with a quantitative and qualitative investigation of voluntary acts, with a view to discovering what is the mode of origin of the resolve (*Entschluss*). He employed a method which consisted in a combination of the *Treffermethode* and the reaction-time experiment. Series of nonsense syllables were presented visually. Certain series consisted of unrelated syllables; others were made up of successive pairs of rhyming syllables; while a third series consisted of pairs of syllables containing transposed consonants (sud, dus). These series were learned thoroughly — each being presented eighty times, and the presentations being distributed over seven days. In the second part of the investigation, a syllable chosen at random was re-presented to the observer, and a definite task was assigned him. Thus, if a syllable from an unrelated series were chosen, the observer was required to give, not an associated term from the same original series, but to give either a syllable which rhymed, or the transposed form. The introspections and the association-times were recorded. Ach points out that inasmuch as his observers were required to break down established associations by an act of will, his records furnish both a qualitative analysis of the content, and a quantitative determination of the strength of the will-consciousness. It is impossible to summarize his results in brief compass.

E. DÜRR. *Voluntary Action and Association.* Pp. 249-250. Dürr objects to the conceptions of voluntary action which have been advanced both by the Associationists and by the Voluntarists. In opposition to these he formulates a definition of his own, which the reviewer will not attempt to render into polite English. "Unter Willenshandlungen sind die durch psychische Vorgänge oder solchen korrespondierende Prozesse im Zentralorgan bedingten, eine bestimmte Erwartung erfüllenden Lebensäußerungen zu verstehen."

VII. MEMORY AND ASSOCIATION, ETC.

W. JERUSALEM. *Remembering and Forgetting.* Pp. 199-203. A description of two personal experiences. The first deals with 'associative and apperceptive transformations' of remembered material,

and suggests a promising point of attack upon the problems of memory. The second deals with the forgetting of a familiar book-title with which an unpleasant incident was associated. The second incident is cited in support of 'a theory of forgetting which heretofore has not received sufficient attention.'

STEPHAN WITASEK. *The Measurement of Memory*. Pp. 202-203. The author's new method is a combination of the 'saving' method and the 'prompting' method. A scale of relative values for the various types of error is proposed. Discussion by Cohn, Lipps and Wirth.

F. SCHUMANN. *The Psychology of Reading*. Pp. 153-183. An extended survey of the literature of this problem.

L. PFEIFFER. *A Method for the Determination of Qualitative Work-types in the School-room*. Pp. 203-207. An analysis of themes submitted by children reveals the existence of typical differences. Pfeiffer distinguishes eleven typical modes of working (descriptive, memorial, inferential, etc.), and numerous pure and mixed types of work.

C. DECROLY. *The Measurement of Intelligence in Normal and Abnormal Children*. Binet's method (physical measurements) is unsatisfactory. Intelligence must be regarded as capacity for adaptation and accommodation; and from this point of view there must be worked out a means of measuring mental functions.

VIII. JUDGMENT, BELIEF.

OTTO LIPMANN. *The Effect of Suggestive Questions*. Pp. 207-209. The author prepared a series of questions whose formulations were suggestive and prejudicial. These were answered by upwards of twelve hundred children and the replies were compared with answers to non-suggestive questions. The types of suggestion employed were: false assumptions, imperfect disjunctions, true and false anticipations. The answers show that questions involving false assumptions and imperfect disjunctions have a greater suggestive power than questions involving false anticipations, that boys are more suggestible than girls, and that suggestibility decreases with increase of age and of training.

AUGUST MESSER. *An Experimental Investigation of the Judgment*. Pp. 258-260. Messer's problem is: What introspective account of the act of judging can be obtained from the trained observer? The author's discussion indicates that, however difficult to lay hold upon and to describe its essential characteristics, this act is

an experience *sui generis*. His observers drew a sharp distinction between mere association and the experience which they called judgment. In this distinction it is not of decisive importance whether the copula precede the substantive or adjectival reaction-word, or whether the reaction-word can be apprehended as a statement regarding the stimulus-word. The reaction is designated as a mere association when the observer is conscious of its automatic or arbitrary character (*e. g.*, when he feels that he could quite as well have replied with any other word). But it is designated as a judgment when he is conscious of having himself related the reaction-word with the stimulus-word. This act of relating is reported to consist in 'catching them together in the focus of consciousness.'

K. BÜHLER. *An Analysis of Complex Processes of Thought*. Pp. 263-266. The procedure consisted in having trained psychologists furnish an introspective analysis of their complex processes of thought. With an introductory 'Do you accept this?' or 'Do you understand this?' an aphorism was read to the observer. As soon as he was able to answer yes or no, he proceeded to give an introspective analysis of the group of experiences which culminated in his answer. Bühler reports that among the component parts of these experiences are to be found ideas of all sorts, and from all departments of sense; but, in addition to these, one finds other contents which are variously designated: thoughts, *Bewusstseinslagen*, *Bewusstheiten* (Marbe, Ach), knowledge, conviction. Bühler therefore distinguishes two sorts of content as present in these experiences: ideas and thoughts (*Gedanken*). The latter he attempts to describe. They are the real components of our thinking; they cannot however be characterized by quality, intensity and the like as ideas can. In thoughts we must rigidly distinguish that sort of *Bestimmtheit* which might be called *Gegenstandsbestimmtheit* (Husserl, Lipps) from that which is given us perceptually (*anschaulich*) in our thinking. Then in order to account for these *Gegenstandsbestimmtheiten* he assumes the existence of a third mental element or function, which he designates *Wissen* and which serves as the substrate of the *Gegenstandsbestimmtheit*. The author of this paper is convinced that his discussion will serve to clear up many of the controverted points of psychology; the reviewer cannot share his optimism.

IX. ABNORMAL PSYCHOLOGY.

W. WEYGANDT. *The Psychological Investigation of Feeble-minded Children*. Pp. 123-135. A review of the literature, and a plea for improved conditions for a continuation of the work.

R. SOMMER. *Individual Psychology and Psychiatry*. Pp. 136-152. The author's chief aim is to discover what, if any, relation obtains between an individual's form of mental disorder and his previous psychical disposition and temperament. He asks two definite questions: In how far may the traits of earlier normal character be observed in the symptoms of the later psychosis? And, to what extent are the peculiar characteristics of the normal individual, at bottom, pathological? In an attempt to answer the former question he discusses, in order, the symptoms of a variety of mental diseases, pointing out the presence or absence of a correlation between pre-neurotic and post-neurotic dispositions and temperaments. While he succeeds in establishing the correlation in certain instances (alcoholism, the neurasthenic depressive form of progressive paralysis), he usually fails to find any evidence of its existence. He urges a coöperation between clinical observation in psychiatry and experimental investigation in psychology, and looks forward to the day when we shall have a medical psychology based throughout upon the results of psychological investigation. Sommer's paper was discussed by Lipps and Neisser.

J. W. B.

TEXT-BOOKS.

Elementary Experiments in Psychology. CARL E. SEASHORE. New York, Henry Holt and Company, 1908. Pp. xi + 218. With envelope of colored papers.

"This manual is designed to meet the requirements for a series of individual experiments in the first course in psychology. It makes individual experiments, as opposed to class demonstrations, practicable, regardless of laboratory facilities or the size of the class. The student is given means and encouragement for pursuing each problem intensively in order that he may acquire independence of thought and action, realize the actuality of mental processes, and get here and there a vision of the vastness, the orderliness, the practical significance, and the charms of mental life.

"No laboratory facilities are required. In this there is a triple gain: it saves the manifolding of equipment, it frees the student from the technicalities incidental to the manipulation of apparatus at a time when his energies need to be conserved for the grasping of the psychological problem, and it saves time for the class period, the experiments being adapted for outside assignments. The apparatus other than that ordinarily at the disposal of students is supplied with the book in the accompanying envelope.

"This is not a laboratory manual. It is a manual of experiments which the student should perform before he is admitted to the laboratory, or in case he does not intend to pursue the subject beyond one course."

With these introductory words Professor Seashore explains the plan and scope of his book. The experiments are designedly of an elementary character; they are well adapted to serve as a substitute for the less satisfactory class-demonstrations, and to equip the student with some degree of pre-laboratory training.

The experiments are judiciously selected. And, what is better, they are described in terms which can scarcely fail to be thoroughly understood by the average undergraduate. Moreover, the significance of the various forms of mental function is discussed in a manner which is calculated to stimulate the interest of the student.

After a brief Introduction addressed to the student, the author gives directions for a series of experiments dealing with visual sensation (Visual After-Images and Visual Contrast). The third chapter treats of the exploration of the visual field, and paves the way for Visual Space which in turn is followed by Auditory Space and Tactual Space. Next in order come Cutaneous Sensations and Weber's Law. The reviewer would suggest that at least the former member of this pair should have preceded the perception experiments; but he is well aware that all American psychologists do not defer the problems of perception until sensation has been worked over. The remaining chapters deal with Mental Images, Association, Memory, Apperception (the meaning-tendency, bias, subjective grouping, reversible perspective), Attention, Normal Illusions (of visual space), Affective Tone, and Reaction Time.

Just so long as local conditions and individual ideals in university communities differ, there must be variations in the current methods of presentation of subject-matter. Certain universities have found it impossible to keep pace, in quarters and equipment, with the rapidly increasing student body; and others have found themselves facing the problem of how to teach a modern system of psychology with no laboratory at all. It is in such situations as these that Professor Seashore's book will prove to be most useful. And the reviewer can readily understand how it will prove to be a boon to many American psychologists.

J. W. B.

La Psychologie Quantitative. J. J. VAN BIERVLIET. Gand, A. Siffer, and Paris, Félix Alcan, 1907. Pp. 219. Also *Revue Philosophique*, 1907, Vol. 63, pp. 1-32, 140-175, 561-592; Vol. 64, pp. 561-587; Vol. 65, 1908, pp. 48-70.

The author distinguishes three phases in the development of psychology, which he calls psychophysics, physiological and experimental psychology. The exponent of psychophysics, the science of the exact relation between mind and matter, is Fechner. The data on which Fechner based his psychophysical law and a short review of the various discussions and criticisms of this law are given. The fundamental error of psychophysics is found in the view that sensation is something comparatively simple, and that the chief interest lies in the metaphysical problem how the mind acts on the body. To this comes the eagerness of the psychophysicists to find exact mathematical formulæ, for which purpose they try to make the physical conditions of the experiments as uniform as possible but fail to take the psychical disposition of the subject into proper consideration. This neglect of individual differences fostered the belief that results obtained from a few subjects are sufficient, and the small number of the subjects used is one of the chief reasons for making these results unacceptable.

The representative of physiological psychology is Wundt. The author discusses in this chapter almost exclusively the experiments on reaction time, association time, etc., of Friedrich and of Trautscholdt. On the whole the criticism of physiological psychology is more favorable than that of psychophysics, although the author objects to the small number of subjects and sees in the results more the promise of future discoveries than actual achievements. Physiological psychology, however, will always find its progress blocked by insurmountable difficulties, because it is burdened with metaphysical notions, as, *e. g.*, the concept of apperception.

Under the title of experimental psychology investigations on very different problems are described, such as Saint-Paul's questionnaire on the 'formule endophasique' and Friedrich's investigations on the quality of mental work of school children at different hours of the day and the effect of the length of classes and of recreations. The author mentions the experiments on memory by Münsterberg and Bigham, by Smith and by himself and gives an account of Binet's work on arithmetical prodigies (Inaudi) and of Toulouse's study of Zola. The last pages are devoted to the description of what the author considers the final method of psychology. Experiments on a

large number of subjects give results obtained under conditions which are not well defined and only incompletely known, whereas laboratory experiments are carried on under better conditions but suffer from the small number of subjects used. The problem is to combine, if possible, the advantages of both methods. The evolution of psychological methods thus arrives at the problem of analyzing the psychical traits of a mass so as to make intercomparison possible. For this purpose a system of psychical units such as that of Toulouse, Vaschide and Pieron is needed.

The text of the book differs from that of the articles of the *Revue Philosophique* only in words at very few places. One recognizes easily the author's predilection for what he calls experimental psychology, a predilection which shows itself also in the presentation of psychophysics and of physiological psychology. It gives, for instance, most decidedly the impression of the author's intention to criticize or to find fault, when he objects to Fechner's experiments on lifted weights, because they were not made on a large number of subjects. The attempt to show the little agreement between Weber's Law and the data on which it actually was based, is interesting although this fact is well known. At some places it appears as if the author connected a somewhat erroneous idea with the meaning of this law, as, *e. g.*, when he points out that the ratios vary from subject to subject. In the description of physiological psychology the author quotes from the French translation of the 'Physiologische Psychologie' which appeared in 1886, and in his discussion of psychophysics none of the investigations which were carried on after Fechner is mentioned. For these reasons one must say that Van Biervliet's discussions of psychophysics and of physiological psychology in so far as the present state of the problems is concerned are, at the best, inconclusive.

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PSYCHOPHYSICAL EFFECTS OF ALCOHOL.

Die Beeinflussung der Sinnesfunktionen durch geringe Alkoholmengen. I. Teil. Das Verhalten von Unterschiedsschwelle und Reizschwelle im Gebiet des Gehörsinnes. (Preisgekrönte Arbeit.) WILHELM SPECHT. Leipzig, Engelmann, 1907. Pp. 115, with 16 figures.

The methodological bearings of this paper have been discussed in an earlier issue of the BULLETIN (Vol. V., pp. 84-88).

Specht finds that the use of alcohol is invariably attended by a

characteristic change of sensory function; and that this change is cumulative, increasing in magnitude and in rapidity with subsequent doses of the drug. The variation in sensitivity follows a characteristic temporal course, increasing gradually from a small magnitude within a few minutes after administration, reaching its maximum in about thirty minutes, and then as gradually waning until the end of an hour, when it has almost or wholly disappeared. In every instance, *alcohol raises the difference limen, but lowers the stimulus limen*—that is, it refines one's capacity to detect a barely audible noise, but blunts one's capacity to discriminate between noises of different intensity. The variation of the difference limen manifests itself chiefly in an increased number of judgments of equality, although there is also a slight increase in the number of erroneous judgments. It seems impossible to give the reader an adequate insight into this remarkable state of affairs, or to depict the uniformity of the author's findings without reproducing excerpts from his tabulated results. Both observers whose results are here quoted have been total abstainers for upwards of ten years; the reviewer has taken the liberty of reducing the average results to a per-centual basis. Table XXIV. shows the daily distribution of correct judgments ($r + g/2$), with and without alcohol, in the determination of the stimulus limen; Table II. shows the analogous results in the determination of the difference limen. The reader cannot fail to be struck by the fact that the dose of alcohol

	Day.	Normal Experiments.								Experiments with Alcohol.			
		1	2	3	4	6	8	10	12	5	7	9	11
Table XXIV. (p. 82).	STIMULUS LIMEN. <i>Per cent. of Correct Judgments.</i>	59	56	62	56	73	66	66	63	85	83	83	84
Table II. (p. 34).	DIFFERENCE LIMEN. <i>Per cent. of Correct Judgments.</i>	74	77	77	78	77	74	83	85	70	70	70	68
Table III. (p. 37).	DIFFERENCE LIMEN. <i>Per cent. of Judgments of Equality.</i>	20	19	16	14	14	13	13	11	32	30	30	32

TABLE XIII. (p. 54).

Minutes.		4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
[Difference Limen.	Normal Experiments.															
	Per cent. of Correct Judgments.	85	91	95	90	93	90	85	91	86	91	91	88	94	85	96
	Experiments with Alcohol (20 c.cm.).															
	Per cent. of Correct Judgments.	97	80	72	72	67	62	52	67	75	72	82	92	90	97	97
	Normal Experiments.															
	Per cent. of Judgments of Equality.	10	13	13	0	6	3	6	3	0	6	6	6	6	10	6
	Experiments with Alcohol (20 c.cm.).															
	Per cent. of Judgments of Equality.	5	20	60	45	55	65	65	55	30	25	25	15	20	5	5

TABLE XXVIII. (p. 97).

Minutes.		2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30
[Stimulus Limen.	Normal Experiments.												
	Per cent. of Correct Judgments.	54	62	54	57	52	55	51	57	59	54	50	64
	Experiments with Alcohol (20 c.cm.).												
	Per cent. of Correct Judgments.	52	57	67	72	77	80	85	97	100	90	97	92
Minutes.		32.5	35	37.5	40	42.5	45	47.5	50	52.5	55	57.5	60
[Stimulus Limen.	Normal Experiments.												
	Per cent. of Correct Judgments.	58	56	62	57	52	55	45	57	55	52	57	57
	Experiments with Alcohol (20 c.cm.).												
	Per cent. of Correct Judgments.	85	77	75	72	75	62	55	50	60	55	52	60

is followed, in the former case, by an increase and, in the latter case, by a decrease in the number of correct judgments. Table III. shows the extent to which the use of alcohol tends to a multiplication of judgments of equality in the discrimination experiments. Tables XIII. and XXVIII. show the temporal relations of the effects of small doses of alcohol. It will be noticed that the variation in differential sensitivity takes the form of a concave curve, with the lowest point of its trough coming twenty-eight minutes after the dose is administered. The variation in the stimulus-sensitivity takes the form of a convex curve, with the highest point of its crest extending from twenty to thirty minutes after the administration of the dose.

How is this contrary effect of alcohol upon the two forms of sensory function to be explained? Specht refers the impairment of discriminative capacity to a contraction of the compass of attention. He points out an analogy in the familiar fact that the normal individual, in a state of relative inattention, finds his capacity to discriminate between simple stimuli (such as clicks of a metronome) very much decreased. In such a state, the first impression has faded out before the second (comparative) impression comes in. Cf. Titchener's third law of attention. The introduction of this analogy does little more than emphasize the fact that discrimination is much more than mere sensation, and make it comprehensible why two such closely related functions should be affected in opposite directions by alcohol poisoning.

J. W. B.

CUTANEOUS SPACE PERCEPTION.

Les signes régionaux. A. MICHOTTE. Travaux du laboratoire de psychologie expérimentale de l'Université de Louvain. Paris, Félix Alcan, 1905. Pp. 195. Six plates and numerous figures.

It is, of course, a familiar fact that different regions of the cutaneous surface possess different degrees of sensitivity. Not only do the limina of pressure, pain and temperature vary between fairly wide limits, but the different regions differ also in their capacity to detect the presence of two compass-points. In the monograph under review, Michotte deals with this latter phenomenon. The definite problem which he attacks is: What is the distribution of cutaneous sensitivity to dual impression?

His experiments have to do, almost exclusively, with æsthesiometry; and his explorations are for the most part confined to the palmar surface of the hand. He employs a slightly modified form of the von Frey compass-point æsthesiometer, and his procedure is essentially in accordance with the method of minimal changes. The work, which is a product of the psychological laboratory of the University of Louvain, consists of experiments carried through with nine observers.

The plan of the investigation was as follows: Upon each cutaneous region explored, he determined the limina of dual impression for a variety of directions radiating from a common center. In making these liminal determinations he first chose an arbitrary center and marked it by means of a dot of ink. Then the æsthesiometer was brought into contact with the skin in such manner that one point rested upon the ink-spot and the other upon a closely adjacent region.

The former point remained in contact with the ink-spot throughout the series — the other point meanwhile sliding across the surface of the skin until the observer was able to detect the presence of the two points. This procedure was repeated for various directions from the common center; and the result was a cutaneous map which marked the outline of the 'æsthesiometric field.' And the investigation consisted in determining the form and size of these fields for various cutaneous regions, and under various conditions of attention and distraction (adding, counting the strokes of a metronome). By 'æsthesiometric field' the author means simply 'the area containing all of those points which were capable of being confused with the central point.'

It was found that, in explorations made without distraction, the 'æsthesiometric fields' are relatively small and constant in size and relatively regular and uniform in shape (circular or elliptical). When the observer's attention is distracted, however, a most interesting and significant phenomenon appears. The fields expand, and their boundaries become exceedingly irregular in outline. Certain parts of the boundaries may assume a rectilinear or even a concave form. But in no case can they extend beyond one of the prominent cutaneous folds of the palm, or of the digital joints. Just so soon as one point of the æsthesiometer passes a prominent fold of the skin, the observer is immediately aware of a duality of impression, no matter to what degree he be distracted (within the limits of the distractions employed in the experiments). It is possible to map out well-marked boundaries of five of these larger 'æsthesiometric fields': the fusiform region, the thenar eminence, the hollow of the palm, the round eminence and the hypothenar eminence. In addition to these, the cutaneous region corresponding to each phalanx of the fingers and thumb also constitutes a separate 'æsthesiometric field.' The author assumes that each of these 'fields' possesses its own peculiar tactual quality, in consequence of which the discrimination of dual impressions becomes possible. This system of qualitative criteria, which may be regarded as 'local signs of the second order,' he calls 'regional signs.' He shows that there is an intimate relation between regional signature and bodily movement. Every field which possesses its own 'regional sign' constitutes a mobile unit of the hand: we have just as many 'regional signs' as we have mobile segments. That every part of the hand which is capable of changing its relative position should possess its own local distinguishing-mark, and that even in a state of relative inattention we should be incapable of confusing these distinguishing-

marks with one another is significant. That these findings furnish yet another confirmation for one of the current theories of space-perception need scarcely be pointed out. And this confirmation becomes even stronger when we remember that the distribution of 'regional signs' is not of such a pattern as one would expect from the anatomical distribution of nerve-supply in the hand.

J. W. B.

BOOKS RECEIVED FROM JULY 5 TO SEPTEMBER 5.

- La dynamique et les trois dmes.* J. PAUL MILLIET. Paris, E. Sansot & Cie, 1908. Pp. 389.
- A History of a Strange Case.* DAVID P. ABBOTT. (Reprinted from the Open Court for May and June, 1908.) Chicago, Open Court Publ. Co., 1908. Pp. 50.
- American Science Series. Ethics.* JOHN DEWEY and JAMES H. TUFTS. New York, Holt & Co., 1908. Pp. xiii + 618.
- Das Seelenleben des Kindes. Ausgewählte Vorlesungen.* KARL GROOS. 2d ed. Berlin, Reuther & Reichard, 1908. Pp. 626. Mk. 4.50.

NOTES AND NEWS.

THE present number of the BULLETIN, dealing especially with experimental psychology, has been prepared under the editorial care of Professor J. W. Baird.

MR. ARTHUR UPHAM POPE, of Harvard University, has been appointed instructor in philosophy at Brown University.

THE following are taken from the press:

THE degree of D.Sc. *honoris causa* was conferred on Professor James Ward at Oxford, on June 24.

DR. SIDNEY E. MEZES, professor of philosophy at the University of Texas, has been elected president of the University, to succeed Dr. D. F. Houston, who recently resigned.

PROFESSOR ALFRED EDWARD TAYLOR, of McGill University, has been appointed to the chair of moral philosophy at the University of St. Andrews.

